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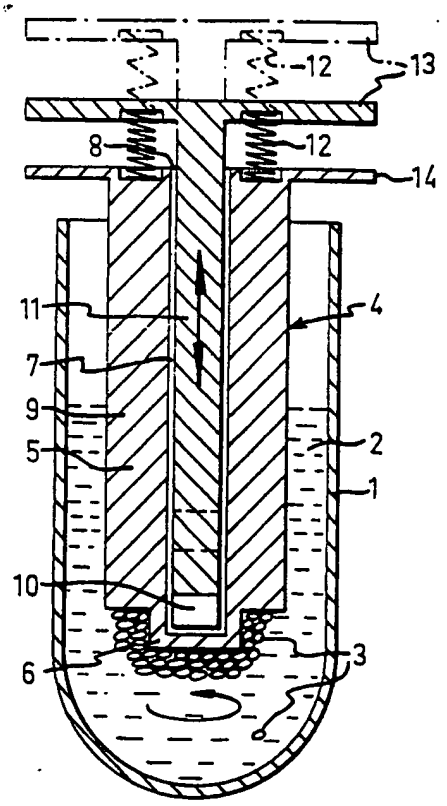
(54) Title: METHOD AND APPARATUS FOR COLLECTING AND DISPERSING FERROMAGNETIC PARTICLES IN A FLUID MEDIUM

(57) Abstract

A method and apparatus for collecting ferromagnetic particles in a gaseous or liquid medium, and dispersing them in a gaseous or liquid medium, in which method a magnet is introduced into said medium. Use is made of a sleeve (5) of a plastic material permeable to the magnetic field, but free of remanence and having a thin-walled nose end (6) and a thick-walled jacket wall. Mounted in the passageway (7) of the sleeve is a permanent magnet body (10) of the type which, when attached to an operating means (11, 13), is movable within said passageway in the longitudinal direction thereof by means of said operating means from the open sleeve end, the permanent magnet being moved by means of said operating means into the closed nose end for collecting the ferromagnetic particles (3). To disperse the particles, the permanent magnet is moved to a position spaced from the nose.



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METHOD AND APPARATUS FOR COLLECTING AND DISPERSING FERROMAGNETIC PARTICLES IN A FLUID MEDIUM

The present invention relates to a method and an apparatus for collecting and dispersing ferromagnetic particles in a fluid medium.

US-3,985,649 discloses a process for separating a substance from a liquid in a container utilising magnetic forces. The substance is formed of ferromagnetic particles which are actuated, for the said separation, by means of an electromagnet immersed in the liquid. The ferromagnetic particles may have been formed of a ferromagnetic core and a reaction product bonded thereto, optionally via a coating, and formed of a first reactant bonded to the core or the coating prior to the introduction of the cores into the liquid, and a second reactant within the liquid. For the said actuation of the ferromagnetic particles, the electromagnet is energised and then attracts the particles and can be removed from the liquid and the container together with the particles.

The ferromagnetic particles thus removed from the liquid and the reaction product which may be bonded thereto, can be subjected to further processing steps in other liquids, in which case the electromagnet may be deenergised.

One disadvantage of this technique is that, after the electromagnet has been deenergised, a multitude of the ferromagnetic particles are retained by the electromagnet due to residual magnetism (remanence). If, for example, the separated particles are to be analysed in respect of reaction yield, the analysis will be inaccurate. The alternative of removing this particle quantity from the electromagnet takes a fairly long time, and this is also the case if the electromagnet is to be cleaned for reuse in a new environment

that must not be contaminated by residual particles originating from a previous use of the electromagnet for the purpose in question.

Furthermore, the electrical lead-ins of the electromagnet constitute an obstacle to easy and convenient handling of the magnet.

It is the object of this invention to eliminate these shortcomings.

This object is achieved by means of a method and an apparatus which has the characteristic features stated in the claims.

The thin-walled, nose-shaped end of the plastic sleeve which is permeable in respect of magnetism but free of remanence, causes the ferromagnetic particles to collect around this end when the permanent magnet is inserted therein, the shoulder interconnecting the nose and the relatively thick jacket wall preventing said particles from following, on the outer side of said jacket wall, the movement of the magnet when displaced from the nose in order to disperse the particles.

The sleeve preferably is an inexpensive mass-produced single-service plastic product for collecting and dispersing the ferromagnetic particles.

The invention will now be described in more detail, reference being had to the accompanying drawing illustrating an uncomplicated basic embodiment of an apparatus for carrying the method according to the invention into effect. A test tube 1 contains a liquid 2 with ferromagnetic particles 3. An apparatus according to the invention, or a probe, for collecting and dispersing these particles is designated 4. It comprises a cylindrical, for example injection-moulded plastic sleeve 5 having a closed nose-shaped end 6. The sleeve 5 has a passageway 7 which is of uniform width and extends from the open end 8 of the sleeve into the nose 6. The nose 6 thus has a thinner jacket

wall than the body 9 of the sleeve, and also a thin end wall. The passageway 7 accommodates a permanent magnet 10 for reciprocal movement within the passageway 7 in the longitudinal direction thereof by means of a shank 11 attached to said magnet in some suitable manner and extending through the open end 8. To effect the reciprocal movement, a coiled spring 12 may be positioned between a flange 13 on the shank and a flange 14 on the sleeve.

The plastic material for the sleeve is so selected that it is permeable to the magnetic field of the magnet 10 at the thin nose wall, but less permeable to this field via the thicker body wall 9. The plastic material has minimum residual magnetism (remanence), if any at all.

When the probe 4 is inserted in the tube 1 and the magnet 10 is moved into the nose 6, the spring 12 being compressed between the flanges 13 and 14 which are held between the fingers of one hand, the ferromagnetic particles 3 will collect on and adhere to the nose. When the magnet is moved in the opposite direction, which may be achieved by easing the finger pressure on the flange 13, the particles 3 are released from the sleeve 5. They cannot accompany the magnet 10 in its upward movement because of the shoulder between the nose 6 and the jacket wall 9 of the body. In this manner, magnetic particles 3 to which adheres a reactant/reaction product/absorbent/adsorbent or the like originating in the liquid 2, are transferred to another test tube containing another liquid for reaction or further treatment therein, after dispersion in said other liquid.

The construction described above is a basic one. It may be made more sophisticated in a manner obvious to those skilled in the art by providing, for example, means for locking the magnet 10 in the collecting position and the releasing/dispersing position, for

example by means of a mechanism resembling the mechanism of a ballpoint pen for locking the retracted and extended positions of a spring-loaded ink cartridge.

Bearing these locking means in mind, a person skilled in the art will have no difficulty in devising a mechanism to provide for rotatability of the sleeve 5 about the shank 11 and the magnet 10 by the same hand which effects longitudinal movement of the magnet 10. Such rotation may be accomplished by means of a rack and gear mechanism, a clock-winding spring, etc. The advantage of having a rotatable sleeve 5, especially if the sleeve is provided with wings, is that the liquid and the ferromagnetic particles therein can be agitated, possibly after they have been released by the sleeve 5.

CLAIMS

1. A method of collecting ferromagnetic particles to which is bonded a reactant/reaction product/bonding agent or the like, in a first gaseous or liquid medium, and dispersing them in a second gaseous or liquid medium, in which method use is made of a magnet for actuation of said ferromagnetic particles, c h a r a c t e r i s e d by utilising a sleeve of plastic material permeable to the magnetic field, but free of remanence and having a thin-walled closed nose end and a thick-walled jacket wall; providing within the passageway of said sleeve a permanent magnet body of the type which, when attached to an operating means, is movable within the passageway from the open sleeve end by means of said operating means in the longitudinal direction of said passageway; moving said permanent magnet within said sleeve, with the sleeve end inserted in said first medium, into said nose end by means of said operating means, for collecting the ferromagnetic particles within said first medium; and moving said permanent magnet, with the sleeve end inserted in said second medium, from the position inserted in said nose end to a position within said sleeve spaced from said nose end, for dispersing said particles in said second medium.

2. A method as claimed in claim 1, c h a r a c t e r i s e d in that the ferromagnetic particles are transferred, with the magnet inserted in the nose, from a liquid in a first container to a liquid in a second container in which the particles are released by moving the magnet to a position spaced from the nose.

3. An apparatus for carrying the method as claimed in any one of claims 1 and 2 into effect, c h a r a c t e r i s e d in that it comprises a cylindrical sleeve (5) of plastic material permeable to the magnetic

field, but free of remanence and having a closed nose-shaped end (6) and a passageway (7) extending from the open sleeve end into the nose, said passageway accommodating a permanent magnet (10) which is movable in the longitudinal direction of said passageway and connected to an operating means (11, 13) for the said movement.

4. An apparatus as claimed in claim 3, c h a r a c t e r i s e d in that a spring (12) is adapted to effect movement of the permanent magnet.

5. An apparatus as claimed in any one of claims 3 and 4, c h a r a c t e r i s e d in that said sleeve (5) is rotatable relative to said magnet (10).

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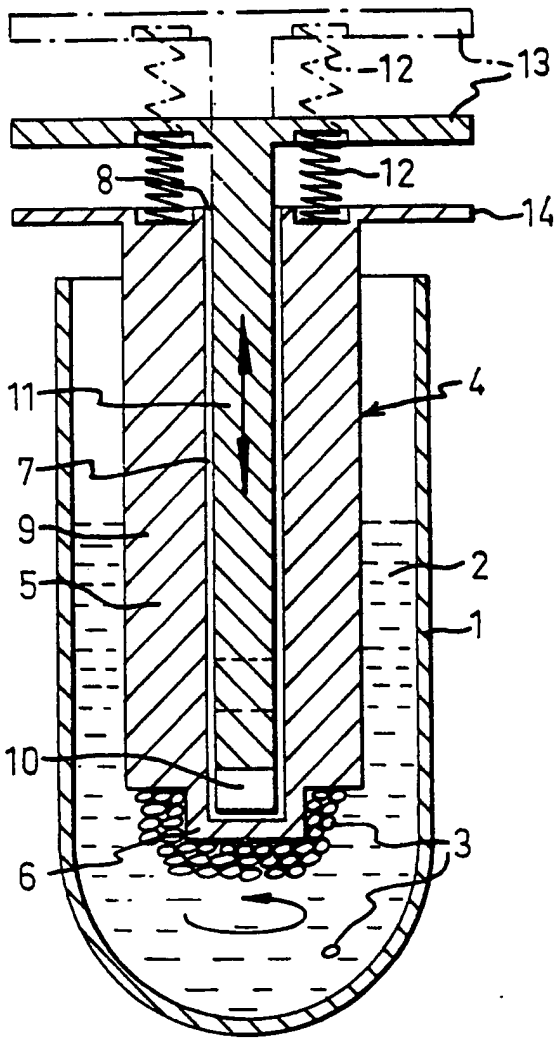

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00120

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC [4]

B 03 C 1/00, 1/28, G 01 N 33/553

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	B 03 C 1/00, /02, /28, /30; G 01 N 33/553

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	US, A, 2 970 002 (SAMUEL LAVIANO) 31 January 1961	3-5 1,2
Y	EP, A3, 0 140 787 (INSTITUT PASTEUR) 8 May 1985 See figures, claims. & FR, 2554016 JP, 60216259 OA, 7851 US, 4649116	1,2
E,X	WO, A1, 86/06493 (LABSYSTEMS OY) 6 November 1986 See figure 4, claims. & EP, 0220255	1-5

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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International Searching Authority	**Signature of Authorized Officer**
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